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Umehara

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[54] **FLOAT SWITCH, A CONTROL APPARATUS AND A WARNING APPARATUS OF AN ENGINE**

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Related U.S. Application Data

[62] Division of Ser. No. 750,962, Jul. 2, 1985, Pat. No. 4,755,790.

[30] **Foreign Application Priority Data**

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Dec. 25, 1984 [JP] Japan 59-275106

[51] **Int. Cl.⁴** **H01H 35/40**

[52] **U.S. Cl.** .... **200/81.9 M**; 200/84 C; 340/625

[58] **Field of Search** .... 73/308, 317, 510; 180/171 X; 340/625 X, 53, 60, 62, 64; 123/198 DC, 351, 335 X; 335/205; 200/84 C, 61.2, 81.9 M

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Primary Examiner—Gerald P. Tolin
Attorney, Agent, or Firm—Flynn, Thiel, Boutell & Tanis

[57] **ABSTRACT**

A float switch and a control apparatus of an internal combustion engine are disclosed. This float switch comprises a float attached to a main body so as to be vertically swung around one end thereof, a magnetic material fixed to the float, and a contact adapted to be closed or opened in response to the approach or removal of the magnetic material. The float switch is provided in the pathway of a collant passage and a lubricating oil passage of the engine. The control apparatus has a warning apparatus which is operative in response to an absence signal from the float switch which is indicative of the absence of the fluid that is being sensed, and has a rotating speed control apparatus to reduce the engine speed. The absence of the fluid is informed to the operator by the warning and the speed reduction. A warning apparatus for an outboard engine to control the engine speed when an abnormality occurs is also provided. This apparatus comprises a rotating speed detecting circuit, a circuit to set the engine rotating speed in correspondence to the abnormality, and a circuit to suppress the engine speed when the detected speed exceeds a preset value. The rotating speed is also reduced when coolant is not sufficiently supplied into the water jacket or when the engine lacks oil.

5 Claims, 7 Drawing Sheets

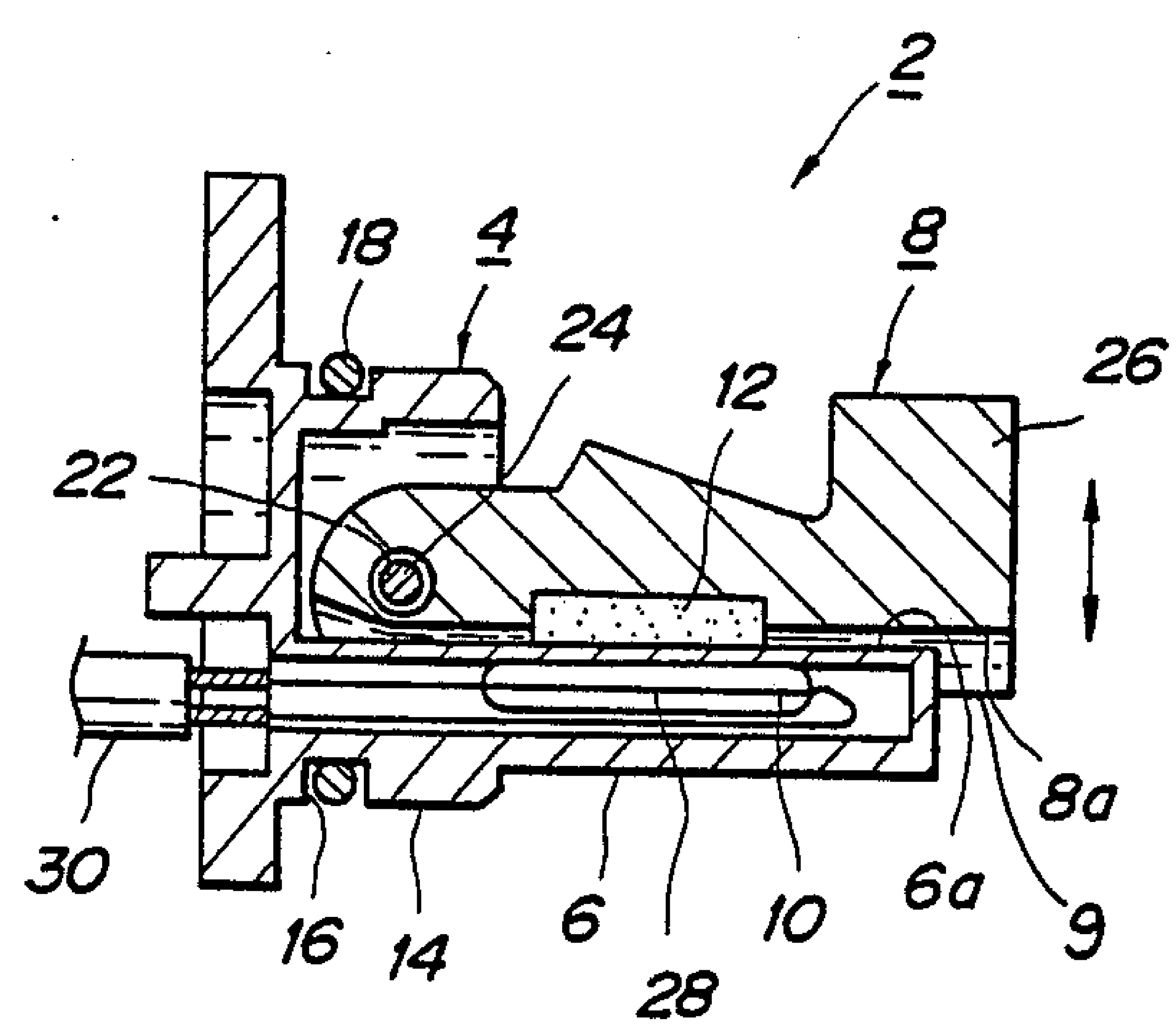


FIG.1

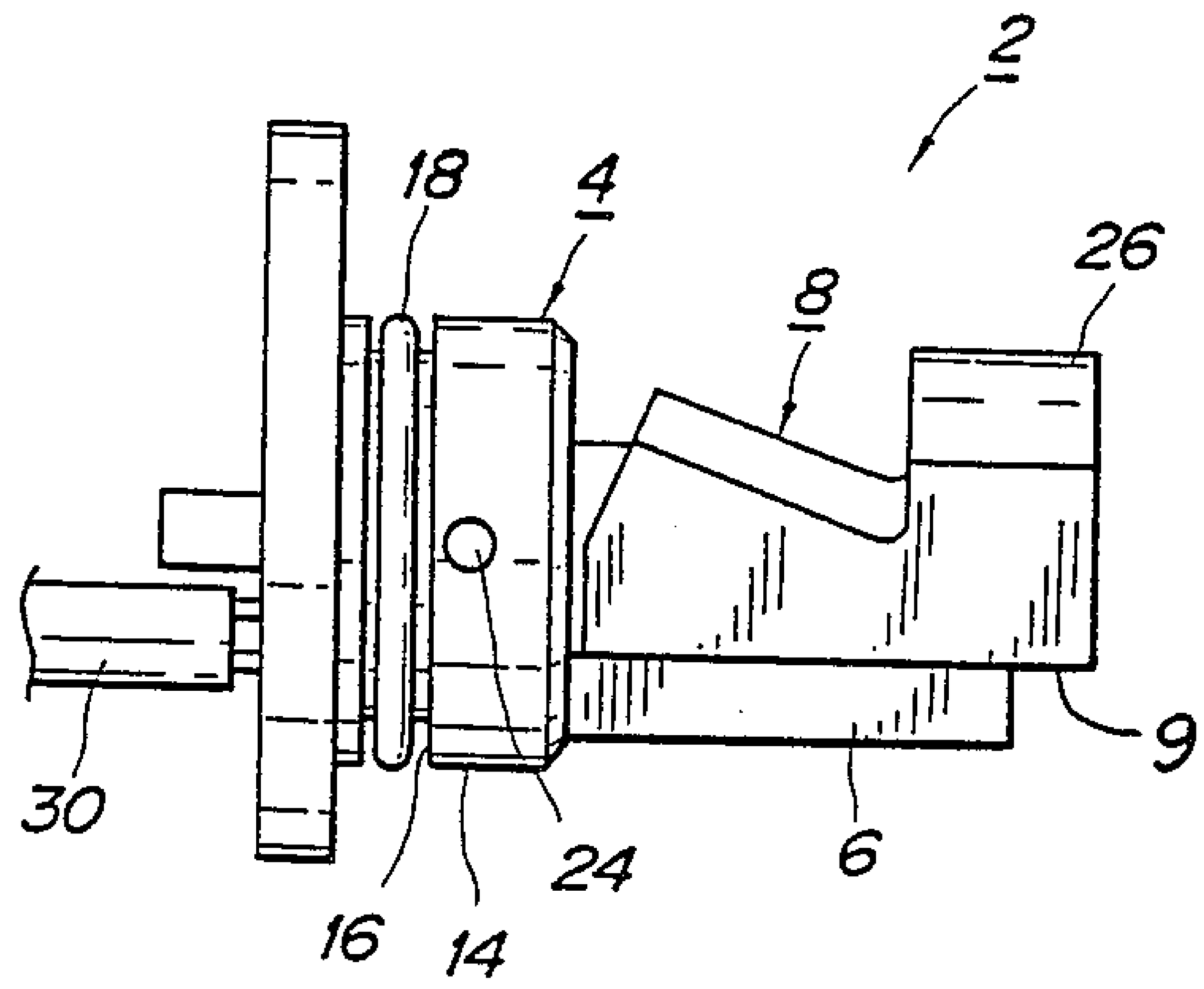


FIG.2

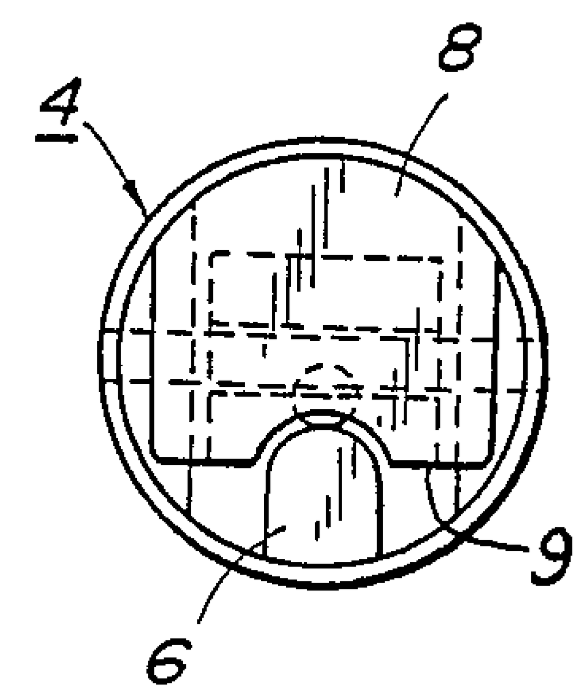


FIG.3

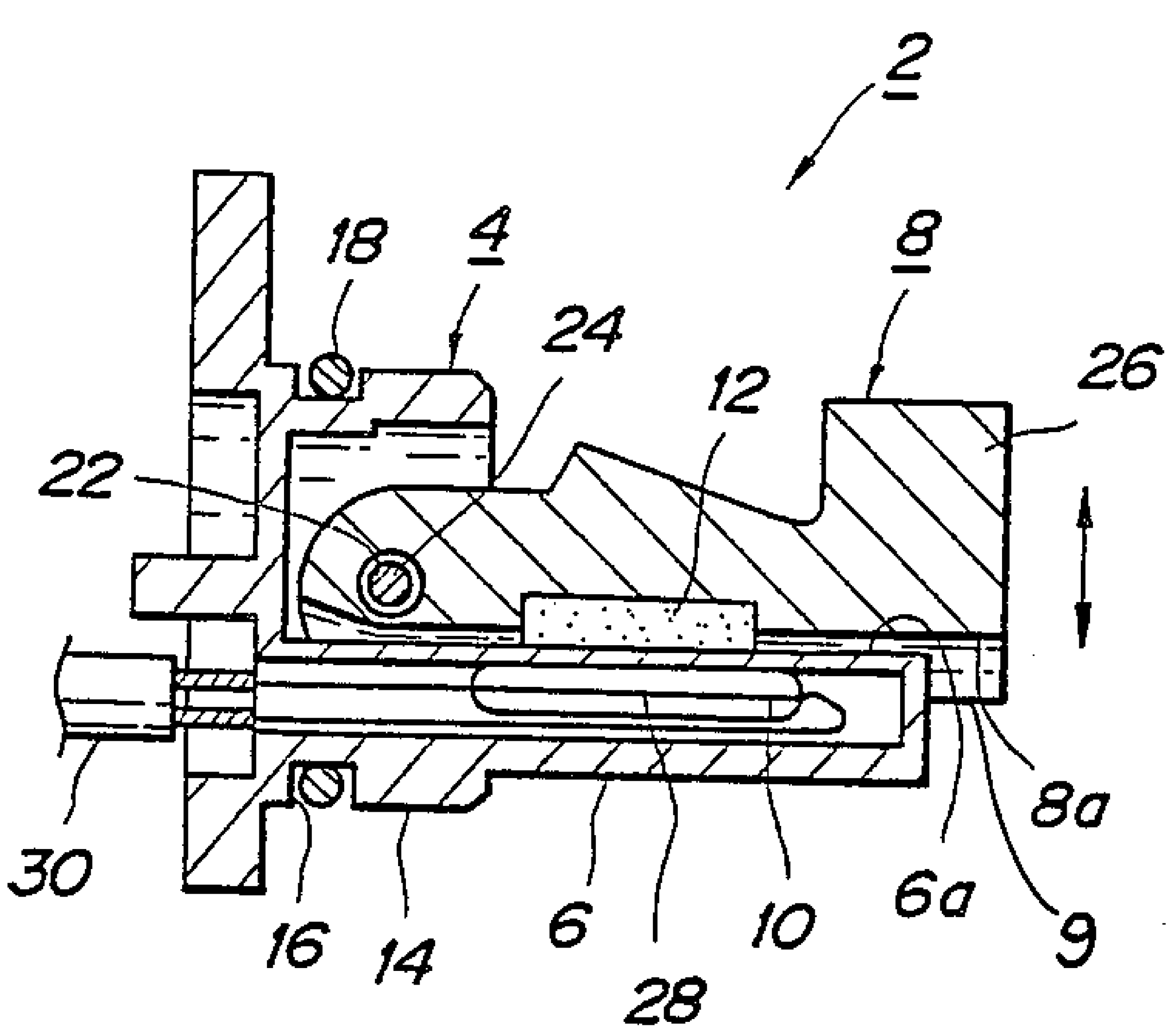


FIG.4

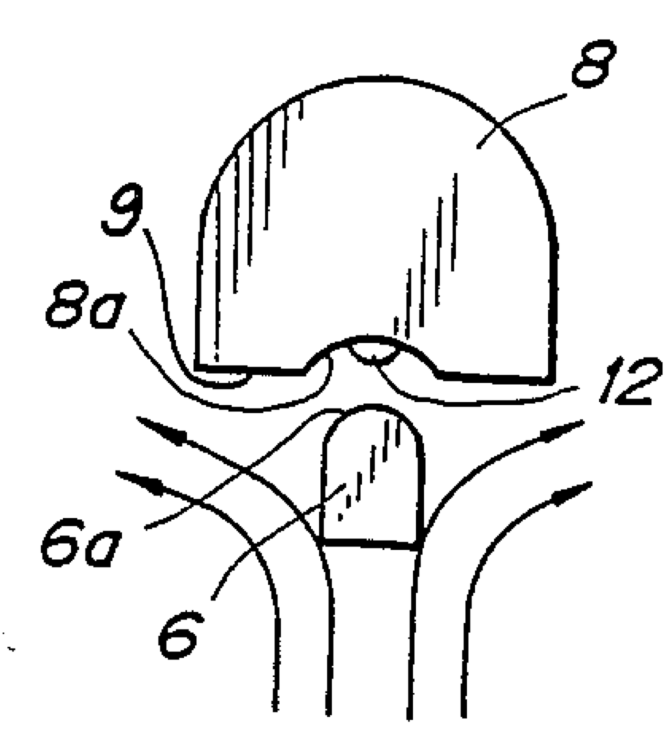


FIG. 5

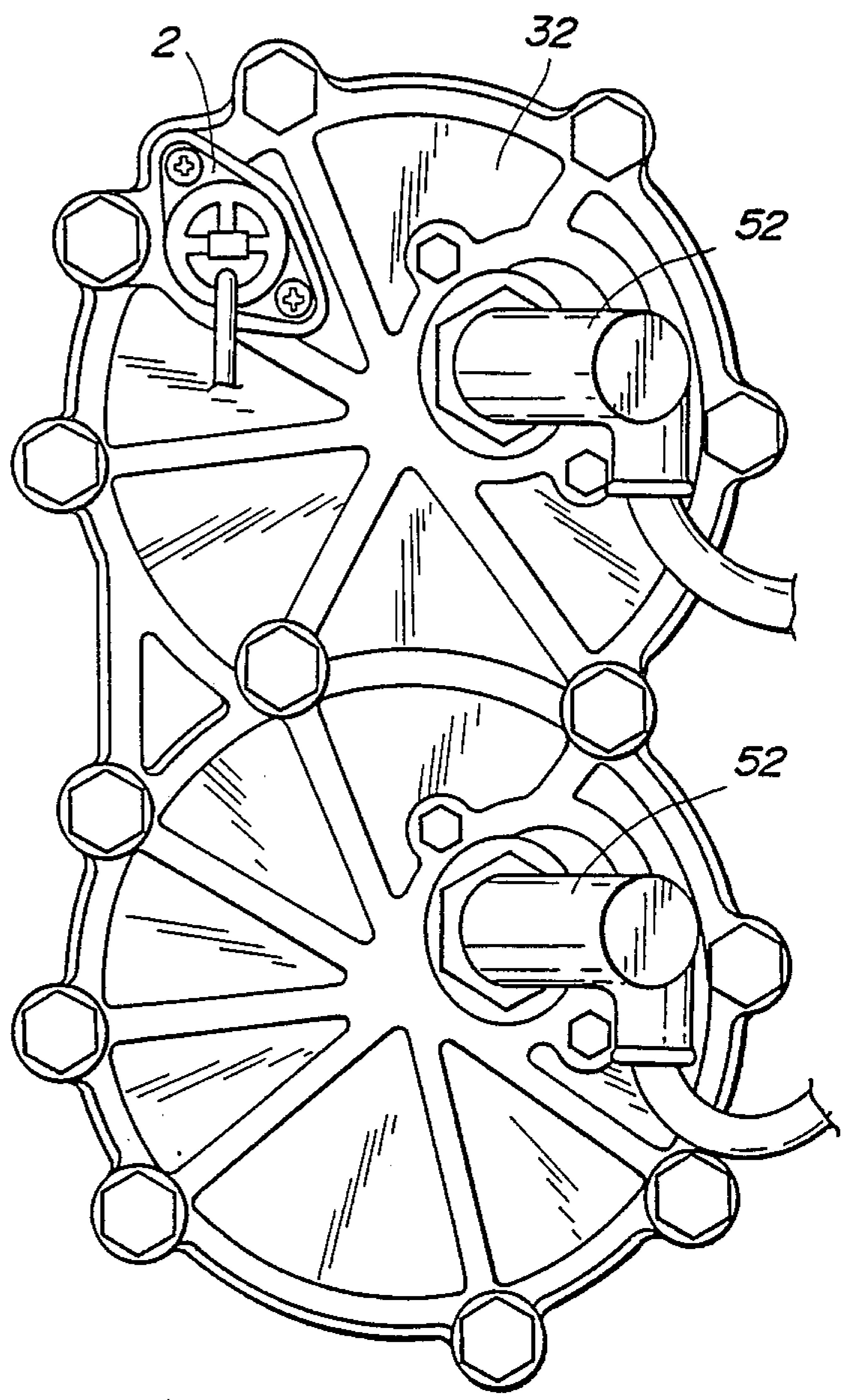


FIG. 6

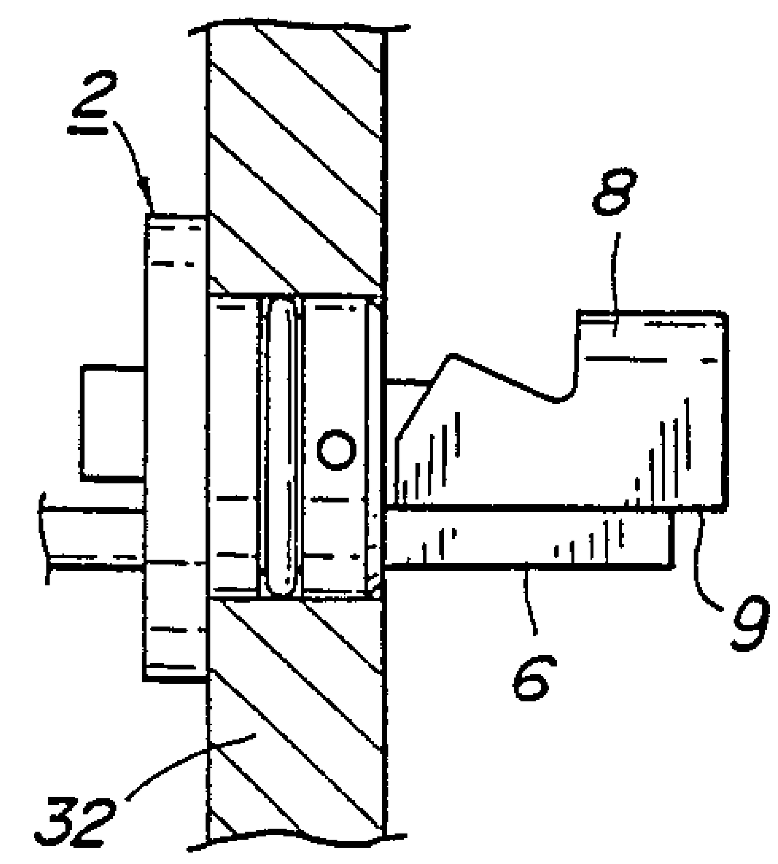


FIG. 7

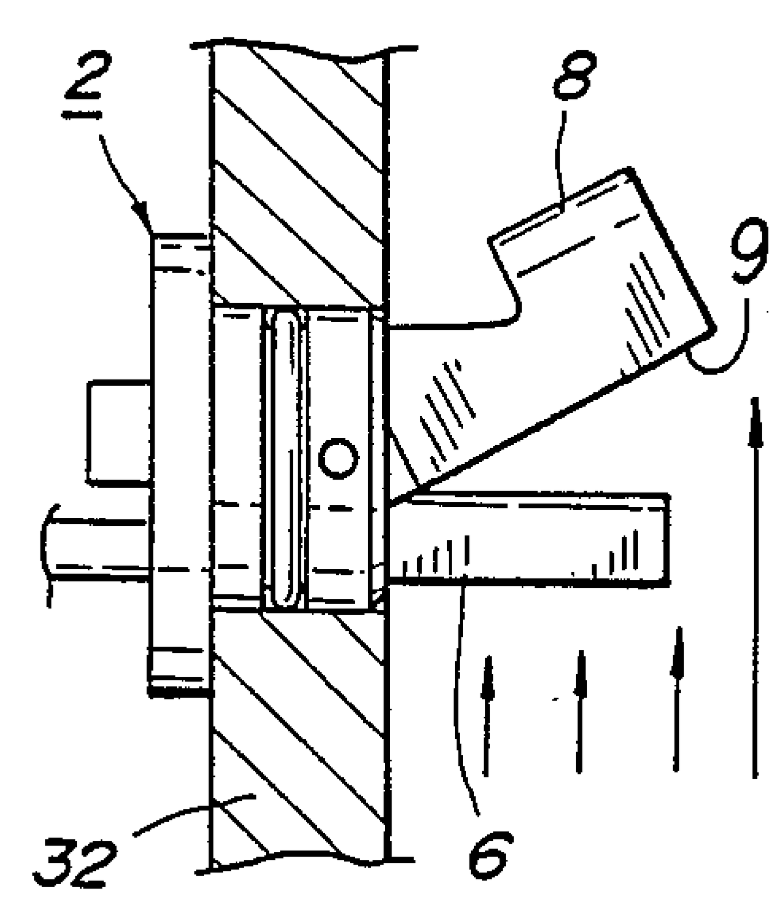
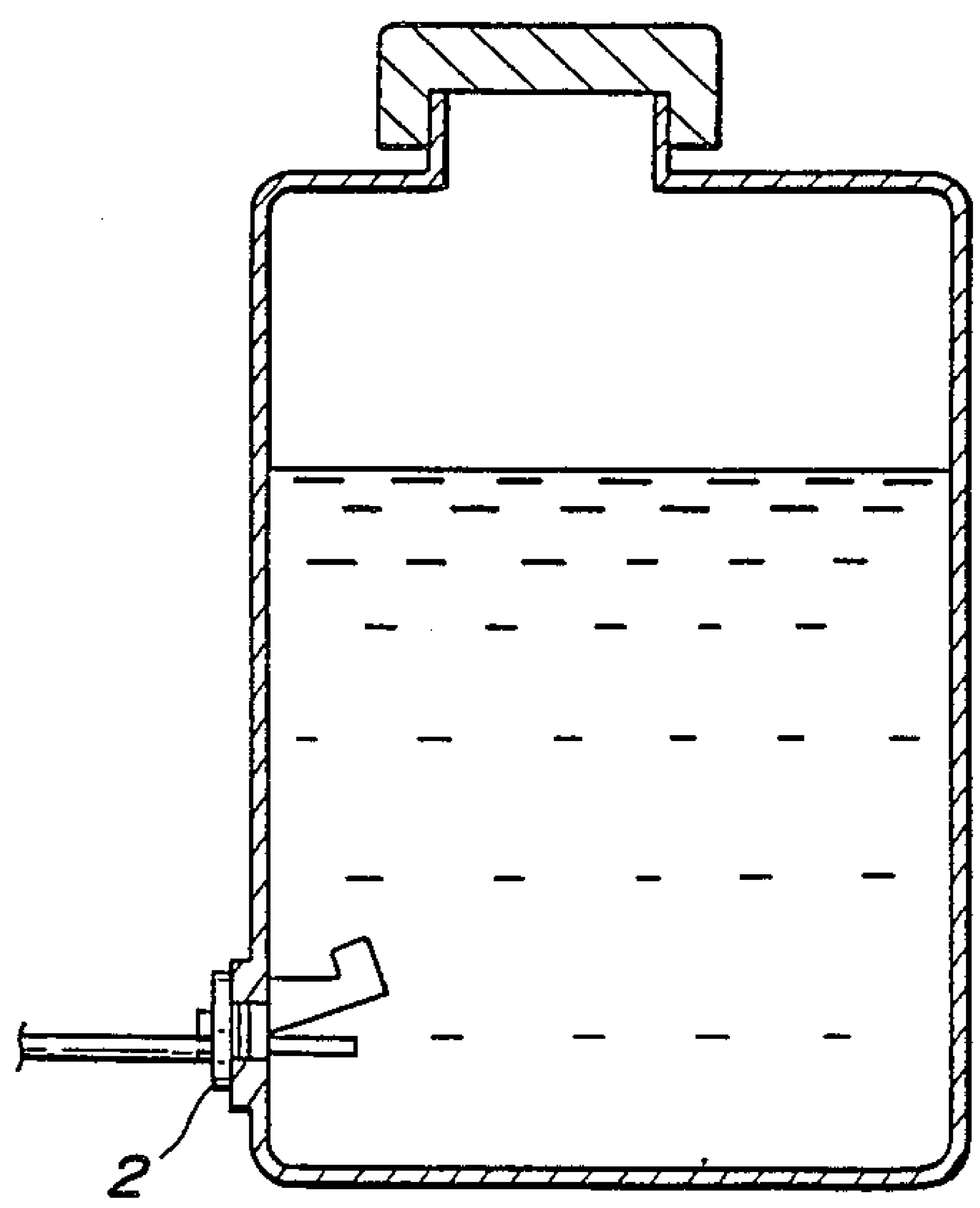


FIG. 8



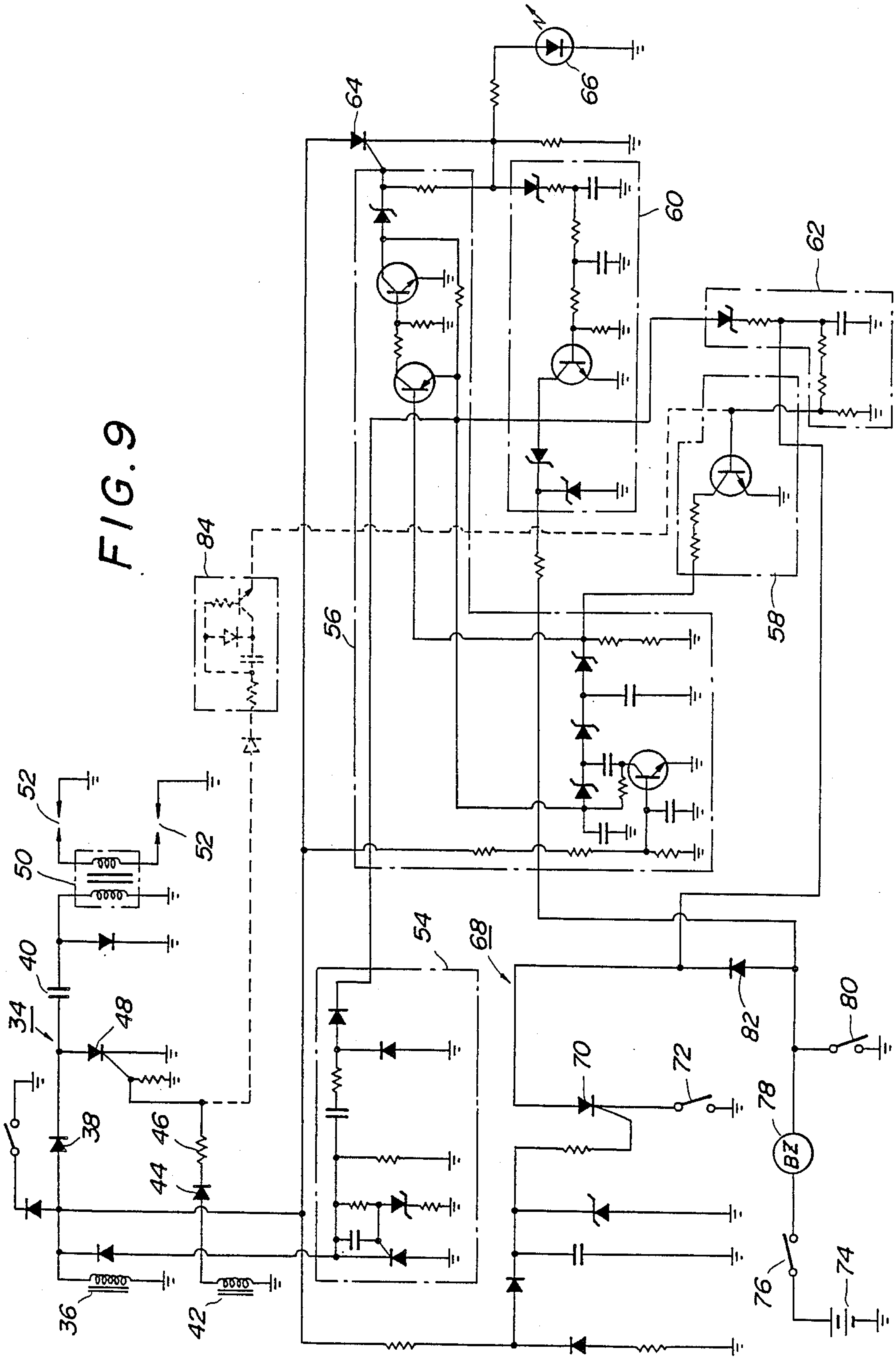


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FIG. 9

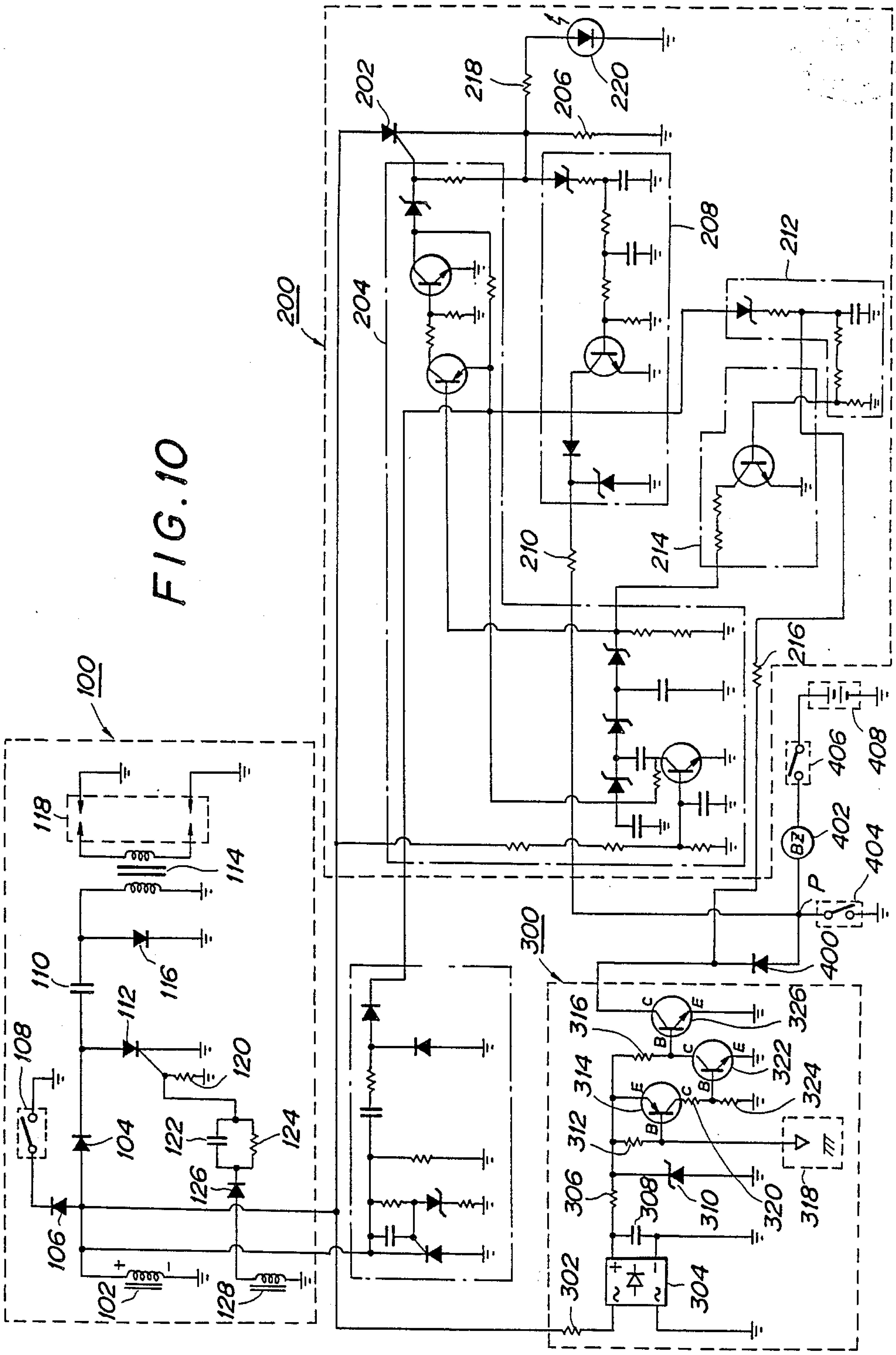
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FIG. 10

FIG. 11

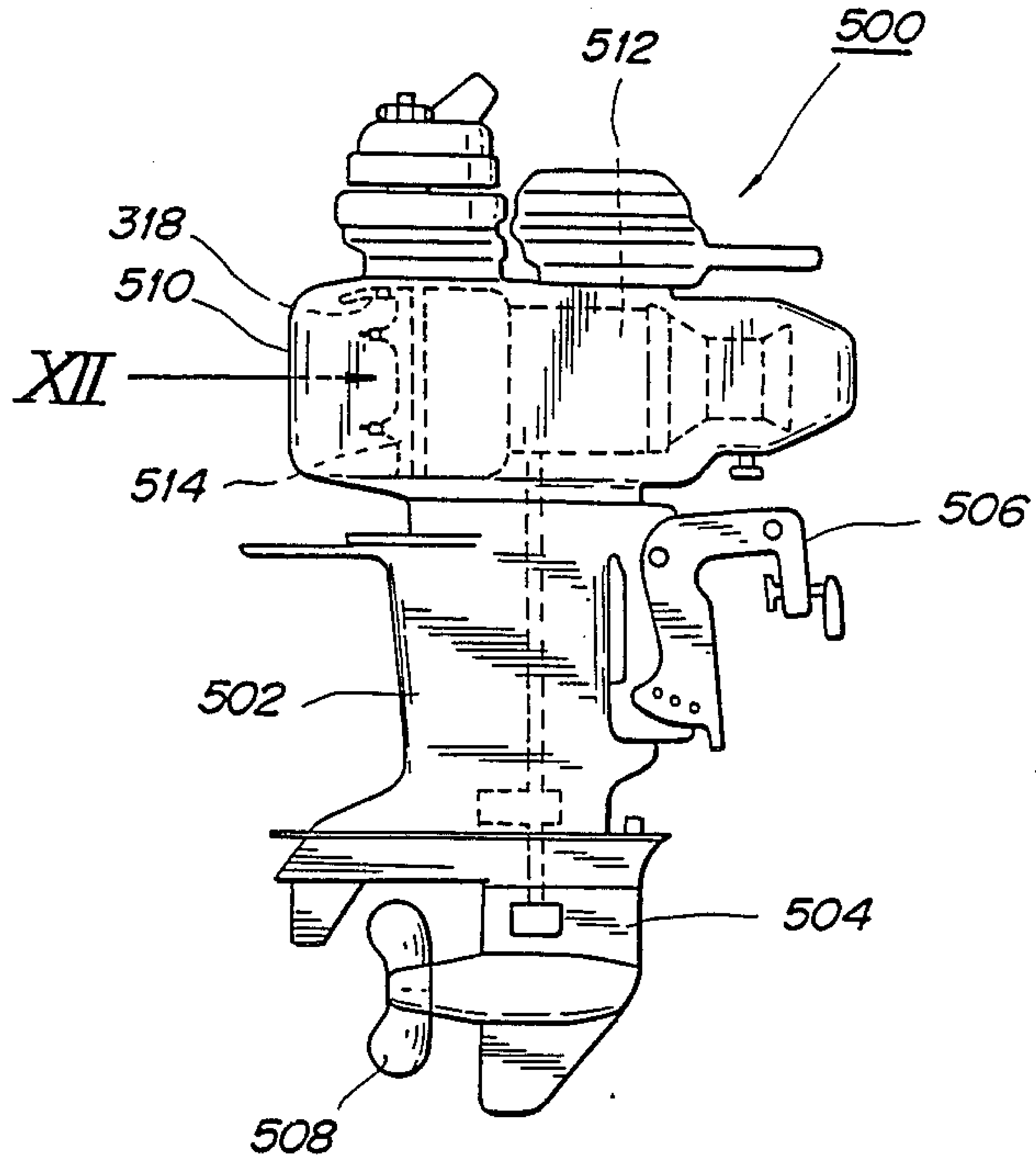


FIG.12

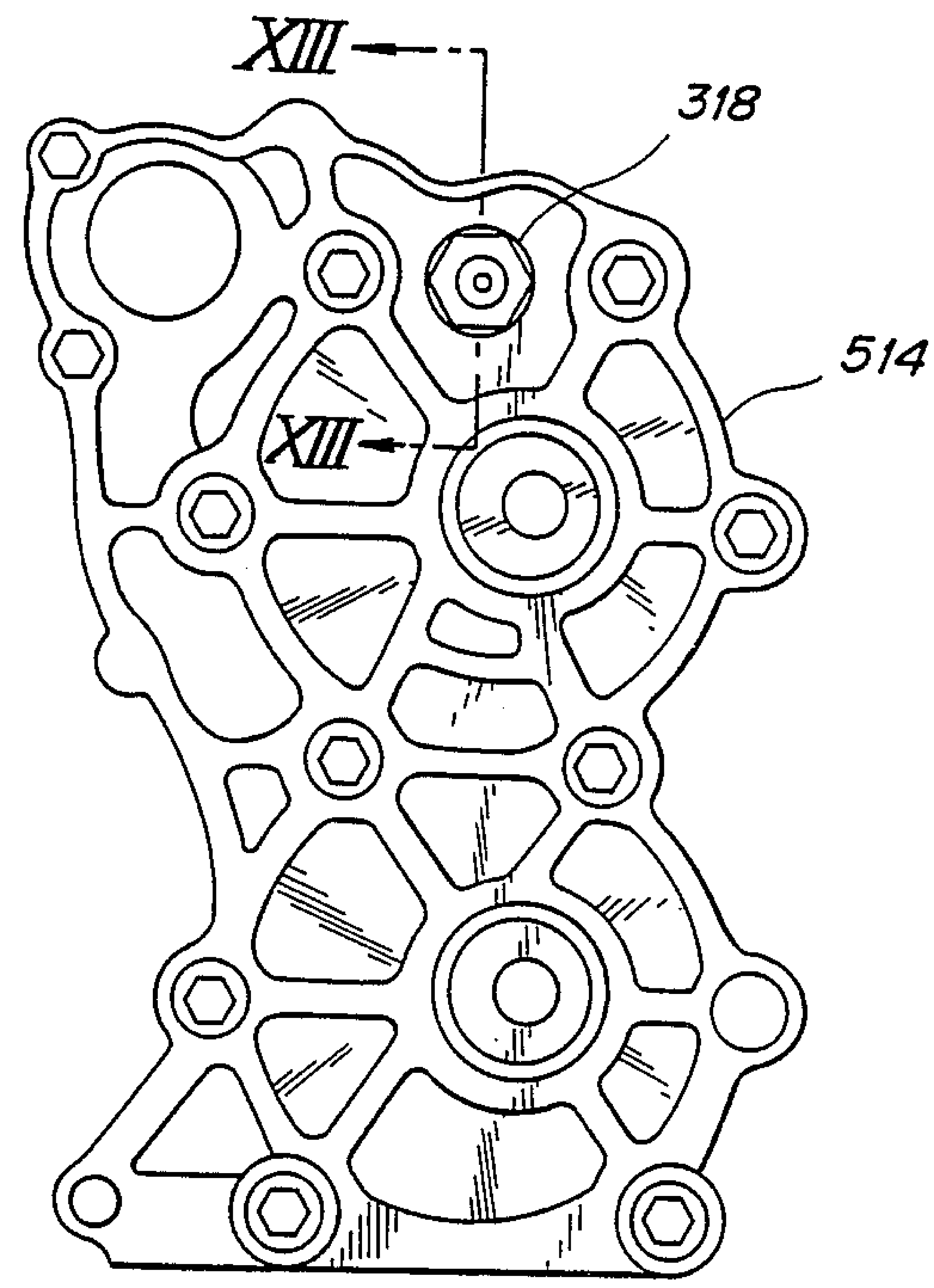
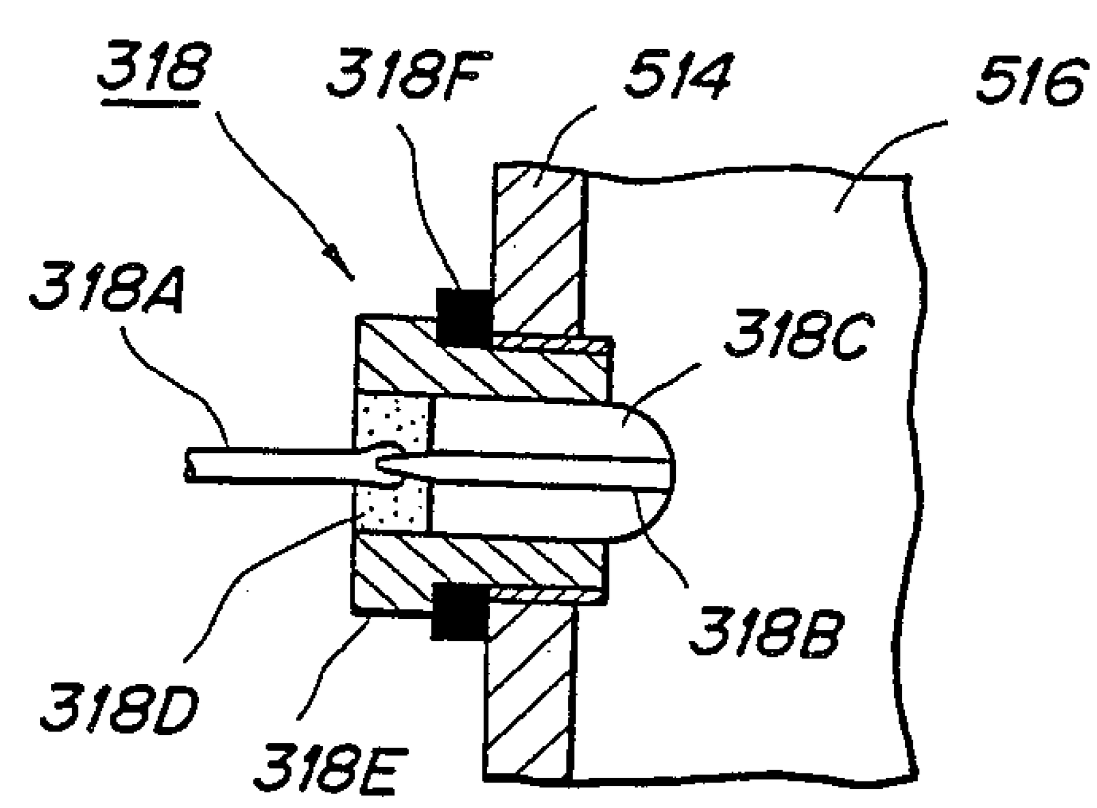


FIG.13



FLOAT SWITCH, A CONTROL APPARATUS AND A WARNING APPARATUS OF AN ENGINE

This application is a division of Ser. No. 06/750962, 7/2/85, now U.S. Pat. No. 4,755,790.

BACKGROUND OF THE INVENTION

The present invention relates to a float switch of an internal combustion engine such as an outboard motor or the like and, more particularly, to a control apparatus of an internal combustion engine in which absence of a function maintaining fluid of the internal combustion engine can be positively detected by use of a small-sized, lightweight and easily attachable float switch, thereby making it possible to prevent damage of the engine.

The invention also relates to an apparatus to prevent overheating of an outboard engine and, more particularly, to a warning apparatus for detecting an occurrence of a cause of an overheating of the outboard engine and generating a warning.

In internal combustion engines, a function maintaining fluid such as cooling water, lubricating oil or the like (hereinafter referred to as a fluid) is allowed to flow through each section in order to make each section function effectively and thereby make the most of the performance of the engine.

If this fluid is lacking or does not flow through the engine, the engine will be damaged due to overheating or the like. For example, in a water-cooled outboard engine, if the coolant is not supplied to the engine due to a failure of the coolant pump or a plugging of an inlet passage for the coolant, the engine will overheat and be damaged. Or, the engine can be similarly damaged due to the lack of lubricating oil, failure of the pump for the lubricating oil, or the like.

Therefore, hitherto, causes of the occurrence of engine damage have been detected by various types of sensors to prevent engine damage. For example, a temperature sensor is attached to the cylinder head or the like of the engine and, when the engine overheats and exceeds a preset temperature, this sensor generates a signal so that the warning apparatus or control apparatus for reducing the rotating speed of the engine is made operative.

However, in such a temperature detecting system, the temperature is detected while the engine is overheating, so that it is difficult to set the temperature, and the temperature of the detecting portion changes due to various factors of the engine. Consequently, there are drawbacks such that the set temperature has to be adjusted and checked depending on the specifications of the engine, and attention must be also paid to the attaching position and attaching method, and the like.

On the other hand, there is known another system equipped with what is called a float switch in which a float member is vertically movably inserted and attached into a pipe member which is vertically disposed, and in which a limit switch is attached at the position corresponding to the level of the height of fluid to be detected; and the limit switch in the pipe member is opened or closed by means of a magnetic material attached to this float, thereby detecting the presence or absence of the fluid.

In such a conventional float switch, however, the length of pipe member has to be changed in dependence upon the height of the fluid to be detected or upon the portion where the switch is attached. In addition, since the fluid surface is detected by way of the vertical movement of the float inserted movably into the pipe member, there are drawbacks such that a long pipe member is inevitably needed for allowing the contact to be opened or closed, and the mechanism becomes large. Further, if it is intended to miniaturize the detecting mechanism by making the pipe member short, the vertical movement range of the float is narrowed, so that the opening or closing of the contact becomes difficult, causing the operation of the limit switch to become uncertain.

Therefore, in such a conventional float switch, it is difficult to make the float switch small and of light weight and to set the attaching position, so that it is difficult to realize a control apparatus which can positively detect the absence of the fluid, such as the coolant or the like, so as to prevent damage of the engine.

On the other hand, generally in water-cooled outboard engines, the cooling water is pumped up by a water pump provided in the gear casing, and this water is circulated in the jacket of the cylinder and thereafter is drained to the outside. Therefore, in the case where the inlet for the cooling water is choked or the water pump fails to operate, the cooling water is not circulated and the engine overheats, so that the cylinder and piston are damaged.

In addition, in the case where a propeller having a pitch smaller than the set standard value is used or a load is light even when the standard propeller is used, the rotating speed of the engine increases more than the speed as needed, so that there is a drawback such that the service life of the engine is remarkably reduced.

Moreover, recently many outboard engines of the separation oil supply type have been used. However, in the case where the quantity of oil falls below a specified value, it is necessary to inform the operator as to the lack of oil.

The warning apparatus for an outboard engine is required because of the above-mentioned viewpoints.

As conventional warning apparatuses for an outboard engine, for example, there are known such apparatuses as disclosed in the Official Gazettes of Japanese Patent Application Laid-Open Nos. 146011/1981, 10772/1982 and 131820/1982. In these warning apparatuses, the temperature of the cylinder head portion of the engine is detected by a temperature sensor attached to the cylinder head of the engine. When the temperature exceeds a preset temperature, a buzzer or the like is made operative or the rotating speed of the engine is simultaneously controlled. In this way, the operator is warned as to the overheated state of the engine. Also, when the oil level is low, the buzzer or the like is likewise made operative, or the rotating speed of the engine is controlled.

In the foregoing conventional warning apparatuses, the set temperature of the temperature sensor attached to the cylinder head portion corresponds to a value while the temperature is increasing after the cooling water of the engine was extinguished. Thus, there is a problem such that it is difficult to select the value that is set. In other words, in dependence on the value of the set temperature, a situation such that a warning is generated in the normal operating state or the generation of the warning may occur too late. Further, means such as grease or the like is required for allowing the heat of the cylinder head to be sufficiently transferred to the temperature sensor, causing an inconvenience such that it is troublesome. In addition, it is necessary to change the set value of the temperature sensor for every engine, resulting in a drawback such that many kinds of temperature sensors having different set values are needed.

SUMMARY OF THE INVENTION

It is a first object of the present invention to provide a small-sized and lightweight float switch which can be easily attached and, more particularly, to provide a control apparatus for an internal combustion engine using such a float switch which can positively detect the absence of the function-maintaining fluid to prevent engine damage.

It is a second object of the invention to provide a warning apparatus for an outboard engine which can surely detect the abnormal state of the engine without using a temperature sensor, and can warn the operator, thereby enabling the service life of the engine to be maintained or lengthened.

The above first object is accomplished by a float switch comprising: a float attached to a main body so that the float can be vertically swung around one end thereof as a swinging center; a magnetic material fixed to the float; and a contact adapted to be closed or opened in response to the approach or departure of the magnetic material. This float switch is provided in a predetermined passage of a function-maintaining fluid, such as the coolant or lubricating oil, of an internal combustion engine. In addition, to attain the first object, there is provided a control apparatus comprising such a float switch, a warning apparatus which is made operative in response to a signal indicative of the absence of the fluid that is sensed by this float switch, and a rotating speed control apparatus for reducing the rotating speed of the engine.

According to one embodiment of the present invention, the float can be vertically swung around one end thereof as a swinging center with regard to the main body. The magnetic material fixed to the float is allowed to approach or move away from the contact due to the swinging of the float, thereby enabling the contact to be positively opened or closed.

In addition, when the float switch detects the absence of the fluid of the engine, it outputs an absence signal, thereby making the warning apparatus and rotating speed control apparatus operative. Thus, the operator can be informed as to the absence of the fluid by way of the warning and the reduction in the rotating speed.

On the other hand, the second object is accomplished by a warning apparatus of an outboard engine for controlling the operation of the engine when an abnormality occurs, comprising: a rotating speed-detecting circuit to detect the rotating speed of the engine; a rotating speed-setting circuit to set the rotating speed of the engine in correspondence to the abnormality; and a suppressing circuit to suppress the rotating speed of the engine when the detected rotating speed of the engine exceeds a predetermined value.

According to another embodiment of the invention, the rotating speed of the engine is suppressed when the detected engine speed exceeds the predetermined value, or when the coolant of the engine is not sufficiently supplied into the water jacket of the engine, or when the lubricating oil of the engine is insufficient.

The above and other objects, features and advantages of the present invention will be apparent from the following detailed description in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1** to **9** show the first embodiment of the present invention, in which:

FIGS. **1** and **2** are respectively a side elevational view and a front view of a float switch;

FIG. **3** is a vertical sectional view in the central portion of FIG. **2**;

FIG. **4** is a front end view in operation of the float switch;

FIG. **5** is a front view of a cylinder head showing an example when the float switch is used;

FIGS. **6** and **7** are side elevational views showing the operational states when the float switch is used;

FIG. **8** is a cross-sectional view showing another example when the float switch is used; and

FIG. **9** is an explanatory circuit diagram of a control apparatus using the float switch.

FIGS. **10** to **13** show the second embodiment of the present invention, in which:

FIG. **10** is a circuit diagram showing one example of a warning apparatus of an outboard engine according to the invention;

FIG. **11** is a side elevational view showing one example of an outboard engine which is used in the invention;

FIG. **12** is an enlarged diagram of the portion which is seen in the direction indicated by the arrow XII in FIG. **11**; and

FIG. **13** is a cross-sectional view as taken along the line XIII—XIII in FIG. **12**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of a float switch for an internal combustion engine according to the present invention, and a control apparatus using this float switch, will now be described in detail with reference to FIGS. **1** to **9**.

Constitution of the float switch

FIGS. **1** to **4** show a float switch **2** of the present invention. This float switch comprises a main body **4**, a projection **6**, a float **8**, a reed switch **10**, and a magnetic member **12**. The main body **4** is made of a nonmagnetic material such as a resin or the like and is constituted in such a manner that a groove **16** is formed in a cylindrical attaching portion **14**, which portion **14** is attached to a cylinder head **32** (FIG. **5**) as mentioned hereinafter, and an O-ring **18** is set around the groove **16**. The main body **4** is provided with the cylindrical projection **6** fixed, here integral, therewith such that the projection **6** horizontally protrudes from the cylindrical attaching portion **14** to face the detecting portion such as a passage for the coolant or the like. As shown in FIGS. **2** and **4**, the upper surface of the projection **6** protrudes upwardly like a convex curved surface to form a protuberance surface **6***a*. The float **8** is formed by expanding a mixture consisting of a rubber and a resin. A hole **22** serving as a swinging center is formed on one side of the float **8**. A pin **24** is rotatably inserted into the hole **22** and is fixed to the attaching portion **14** of the main body **4**. Thus, the float **8** is attached such that it can be freely swung so as to come into contact with or be moved away from the projection **6**. As evident from FIGS. **1** and **4**, the float **8** has a lower surface **9** which is flat. A concave groove **8***a* is formed in the lower surface **9** of the float **8** so as to be in conformity with the protuberance surface **6***a* of the projection **6**. Due to this, the float **8** is positioned so as to be supported on the projection **6** when the float descends. The float **8** is formed in such a manner that the rotary end portion **26** is large and this rotary end portion **26** projects outwardly beyond the projection **6**.

The reed switch **10** is positioned within the projection **6** so that the overlapping movable contact **28** extends horizontally. After the reed switch **10** is attached, it is fixed in position using a potting material and is connected to a lead wire **30**. The magnetic member **12** is fixed onto the lower groove surface **8***a* of the float **8** at a position corresponding to the contact **28** so as to permit the contact **28** of the reed switch **10** to be connected or disconnected.

FIGS. **6** and **7** illustrate a use example of the float switch **2** in the case where the absence of the fluid of a water-cooled engine, such as an outboard engine or the like, is detected by this float switch. The attaching portion **14** of the main body **4** is attached to the cylinder head **32** such that the projection **6** projects into the coolant passage (not shown) of the cylinder head **32** with the float **2** being on the downstream side of projection **6**. Thus, as shown, in FIGS. **4** and **7**, the flat lower surface **9** faces opposite the direction of fluid flow, an inherent operational advantage of which is that the float **8** is highly sensitive to variations in fluid flow. At this time, the attaching portion **14** and the cylinder head **32** are sealed by means of the O-ring **18** provided in the groove **16**, thereby preventing leakage of the coolant. When the engine is stopped and no coolant flows, as shown in FIG. **6**, the float **8** pivots downwardly into contact with the projection **6** and thereby allowing the magnetic material **12** to approach the contact **28**. Thus, the contact **28** is closed and the float switch **2** is turned on. When the engine is activated and the coolant starts flowing, as shown in FIG. **7**, the float **8** swings upwardly away from the projection **6** and thereby causes the contact **28** to be moved away from the magnetic material **12**. Thus, the contact **28** is moved into the normally open position and the float switch **2** is turned off. The absence of the coolant can be detected by use of these "ON" and "OFF" signals. In the case where the absence of the coolant is detected, the warning apparatus or the like is made operative, thereby enabling damage of the engine to be prevented. Practically speaking, when no coolant flows after the engine is activated, the float switch is turned on. Or, when the coolant does not flow during operation of the engine, the float switch **2** is turned on. In this way, a measure for informing as to the absence of the coolant can be provided. The foregoing float switch **2** is not limited to the detection of the absence of the coolant but can obviously be used to detect, for instance, the height of the surface of the fluid such as a lubricating oil or the like as shown in FIG. **8**.

As described above, the float switch **2** is constituted in such a manner that the rotary end portion **26** of the float **8** is swung vertically as indicated by arrows in FIG. **3**, thereby allowing the magnetic material **12** to approach or be moved away from the contact **28**, thereby permitting the contact **28** to be closed or opened. Therefore, there is no need to use the conventional pipe member into which a float is slidably inserted. Also, the whole mechanism can be made small and of light weight without causing the foregoing drawback such that the operation becomes uncertain. In addition, the attaching position of the float switch can be simply changed by easily shifting the main body **4** to an arbitrary position without changing the length of pipe member in the conventional float switch. In this case, according to this embodiment, since the rotary end portion **26** of the float **8** protrudes beyond the projection **6**, upon detection of the fluid which is flowing, it is possible to prevent a drawback such that, as shown in FIG. **4**, the float **8** cannot be upwardly moved because the fluid that does not hit the projection **6** also flows laterally due to the fluid which hits the projection **6** and flows laterally. In other words, the float **8** can be allowed to receive the flow pressure of the fluid by way of the projected rotary end portion **26**, thereby causing the float **8** to be upwardly moved. On one hand, since the rotary end portion **26** is large, a large buoyancy is produced when the fluid exists so that the float **8** is upwardly moved. Contrarily, when no fluid exists or when the surface of the fluid is at a position lower than the location where the float switch is set, the float switch quickly descends due to the weight thereof. Thus, the operation of the float **8** can be securely performed with the aid of the positioning of the protuberance surface **6***a* of the projection **6** and of the groove surface **8***a* of the float **8**, thereby allowing the opening or closing operation of the contact to be certainly performed.

If the float switch **2** is turned upside down such that the float **8** is arranged below the projection **6**, this float switch can also be operated. It will be appreciated in this case that the opening and closing of the contact **28** are reversed as compared with those mentioned above.

Constitution of the control apparatus using the float switch

A control apparatus of an internal combustion engine using the above-described float switch **2** will now be explained with reference to FIG. **9**.

In FIG. **9**, reference numeral **34** denotes a capacitive discharge ignition circuit of the magnet type. In this ignition circuit, an output which is generated in a charging coil **36** of a capacitor by means of a magnet rotor (not shown) which is rotated synchronously with a crankshaft (not shown) is charged into a capacitor **40** through a diode **38**. On the other hand, an output which is generated in a pulser coil **42** flows through a diode **44** and a resistor **46** to a gate of a thyristor **48**, so that the thyristor **48** is turned on. When the thyristor **48** is turned on, the charge on the capacitor **40** is discharged and a current flows through an ignition coil **50** so that a spark is caused between two spark plugs **52**. A numeral **54** denotes a power supply circuit to supply a power source to each of circuits **56**, **58**, **60**, and **62** mentioned later.

The numeral **56** is a rotating speed-detecting circuit; **58** is a rotating speed switching circuit; **60** a spark extinction detecting circuit; and **62** a timer circuit. These circuits constitute rotating speed control means. The rotating speed detecting circuit **56** receives the output of the charging coil **36** and detects the rotating speed of the engine. When the rotating speed exceeds a first set rotating speed as an over-rotating speed, the circuit **56** outputs a signal to a gate of a thyristor **64**, so that this thyristor is turned on. When the thyristor **64** is turned on, the output of the charging coil **36** is short-circuited through the thyristor **64** and the capacitor **40** is not charged, so that the spark is extinguished. The output of the charging coil **36** is not inputted to the detecting circuit **56** due to this short-circuit and the thyristor **64** is turned off. Thus, the capacitor **40** is charged and the spark is generated. When the rotating speed is increased due to the generation of the spark, the detecting circuit **56** functions to extinguish the spark. The operation of the ignition circuit **34** is controlled by repeating the above-described operation and thereby allowing the engine to be operated at a speed less than the first set speed.

Generally, in the above-mentioned state, the operator can recognize the over-rotating speed due to an increase in vibration of the engine and will have tried to reduce the engine speed. However, if such a change of the engine in the operating state is small, there could be a case where the operator is not aware of the over-rotating speed and continues the operation. This state is undesirable for durability of the engine. To prevent such a situation, there are provided: the spark extinction detecting circuit **60** to detect the extinction of the spark due to the turn-on of the thyristor **64** by the rotating speed-detecting circuit **56**; the timer circuit **62** which starts the operation in response to the detection signal from the circuit **60** and outputs a signal after an expiration of a predetermined time; and the rotating speed switching circuit **58** which operates in response to the signal outputted from the timer circuit **62** and switches the speed to a second set rotating speed lower than the first set rotating speed and then makes the circuit **56** operative. With such an arrangement, the engine speed is controlled to the lower second set rotating speed after an elapse of the predetermined time, thereby making it possible to actively inform the operator that the engine is rotating at an overspeed and to protect the engine. A numeral **66** denotes a light emitting diode which emits a light when the spark extinction operation is executed and thereby informs the operator for visual confirmation.

A constant voltage circuit **68** consists of a diode, a resistor, a capacitor, and a Zener diode and serves to make the output voltage of the charging coil constant. A thyristor **70** is turned on in response to an output of the constant voltage circuit **68**. A first float switch **72** is connected to the cathode side of the thyristor **70**, while the switching circuit **58** is connected to the anode side. The first float switch **72** is constituted as described above and is used to detect the absence of the engine coolant. This float switch is set at the uppermost position of the coolant passage.

A numeral **74** denotes a battery; **76** is an ignition switch; and **78** is a buzzer which functions as a warning means. This buzzer is connected to a second float switch **80** and to the timer circuit **62**. This second float switch is also similarly constituted as mentioned above and serves to detect the absence of the engine lubricating oil in its tank or sump (not shown). The buzzer **78** is also connected to the anode side of the thyristor **70** through a diode **82**.

The operation by the first float switch **72** will now be explained.

When the ignition switch **76** is turned on to start the engine, the pump is driven and starts supplying the coolant. It takes a certain time from the start of the engine until the coolant reaches the first float switch **72** disposed at the position of the uppermost level of the coolant passage. Therefore, the first float switch **72** is kept "ON" for a certain time duration after the start of the engine. On the other hand, the ignition circuit **34** is made operative not only by the turn-on of the ignition switch **76** but also generates an output at the charging coil **36** by the rotation of the magnet rotor due to the engine cranking or the like. The thyristor **70** is turned on only when it receives the output of the constant voltage circuit **68** for making the output voltage of the charging coil **36** constant. When the first float switch **72** and thyristor **70** are turned on, a current flows through the battery **74**, ignition switch **76**, buzzer **78**, diode **82**, thyristor **70**, and first float switch **72**, and the buzzer **78** rings. On the other hand, a part of the rotating speed switching circuit **58** is short-circuited through the thyristor **70** and first float switch **72**, so that the rotating speed-detecting circuit **56** is made operative and thereby allowing the engine to be operated at the low second set rotating speed.

Therefore, upon activation of the engine, the buzzer **78** does not ring only by the turn-on of the ignition switch **76**. But, when the magnet rotor is rotated due to the engine cranking or the like, the buzzer **78** rings at this time by the output of the charging coil **36**. The buzzer **78** continuously rings until the coolant reaches the first float switch **72** and causes this switch to be opened and hence turned off. Simultaneously, the engine is operated at the low second set rotating speed and the light emitting diode **66** is allowed to emit the light. When the coolant reaches the first float switch **72** and this switch is turned off, the buzzer **78** stops ringing. Also, the low-speed operation at the second set speed is released and the light emitting diode **66** stops emitting the light.

Due to this, the operator knows that the coolant has not reached the first float switch **72** while the buzzer **78** is ringing after the engine is activated; therefore, he does not speed-up the engine during that period. The operator also knows that the supply of coolant is normal due to the stopping of the ringing of the buzzer. Also, he knows when he can speed-up out of the low-speed operation of the engine due to the stoppage of the light emission of the light emitting diode **66**. In this way, the operator can initiate the ordinary running of the engine. With this arrangement, damage to the engine due to overheating or the like can be prevented and the engine is protected, resulting in improvement in durability. It will be understood that unless the buzzer **78** stops ringing after the start of the engine, the coolant is not normally supplied, so that the operator knows of the abnormal state.

On the other hand, in outboard engines or the like, there is a case where the operator intends to start running immediately after the start of the engine. In this case, low-speed operation at a speed less than the second set rotating speed is performed until the coolant reaches the first float switch **72**, so that the rotating speed cannot be increased. Therefore, as indicated by a dotted line in FIG. **9**, a second timer circuit **84** which is made operative in response to the output signal of the pulser coil **42** is separately provided. Due to this second timer circuit **84**, the rotating speed switching circuit **58** is controlled so as not to be made operative until a constant time elapses after the start of the engine due to the cranking. The set time by the second timer circuit **84** is set to be slightly longer than the time which is required from the start of the engine until the coolant reaches the first float switch **72**.

With this control apparatus having the second timer circuit **84**, when the running is initiated immediately after the activation of the engine, the buzzer **78** rings but the engine can be operated to the high first set rotating speed. In the case where no coolant is supplied, the buzzer **78** continues to ring and after an expiration of the set time, the switching circuit **58** is made operative by the timer circuit **84**, thereby allowing the engine to be operated at a low speed less than the low second set rotating speed. Due to this, the operator knows that the coolant is not being supplied normally, so that damage to the engine can be prevented by performing a measure such as stopping the engine or the like.

In the ordinary running state, when no coolant is supplied because of a failure of the pump or the like and the first float switch **72** detects the absence of the coolant and is turned on, the buzzer **78** rings and also the engine is operated at a low speed less than the low second set rotating speed by means of the switching circuit **58**. Thus, the operator knows that the coolant is not supplied, and this thereby enables the damage to the engine to be prevented.

The operation by the second float switch **80** will now be described.

The second float switch **80** may be attached to the side wall of a tank (not shown) as shown in FIG. **8**. This switch detects the absence of the lubricating oil in the tank and is turned on when the oil is reduced to a level below a predetermined quantity. When the lubricating oil is reduced to a level below the predetermined quantity during the running of the engine, and the second float switch **80** detects the absence of the lubricating oil and is turned on, a current flows from the battery **74** to the switch **80** so that the buzzer **78** rings. When the buzzer **78** rings, a part of the timer circuit **62** is simultaneously short-circuited through the second float switch **80**. The rotating speed switching circuit **58** starts operating after an expiration of a predetermined time from the start of the operation of the timer circuit **62**, thereby making the detecting circuit **56** operative for allowing the engine to be operated at a speed less than the low second set rotating speed.

As described above, when the second float switch **80** is turned on during engine running, the buzzer **78** rings first and then the engine is operated at a low speed less than the low second set rotating speed after an expiration of the predetermined time by the timer circuit **62**. Thus, the operator knows that the lubricating oil is reduced to below its predetermined quantity and that damage to the engine can be prevented. In the case where the second float switch **80** is turned on during operation at a speed less than the low second set rotating speed, only the buzzer **78** rings.

If the second float switch is turned off by supplying a desired amount of lubricating oil into the engine after the reduction of the lubricating oil is detected, then the above-mentioned operation is released and the engine can be operated to the high first set rotating speed.

The operations when the absence of the coolant and the absence of the lubricating oil are respectively detected by the first and second float switches **72** and **80** are the same in that the buzzer **78** rings and the engine is operated at a low speed less than the second set rotating speed. However, since the operation sequences differ as explained later, the operator can discriminate between which absence is detected.

Practically speaking, upon starting the engine, in the case where the absence of the coolant is detected and the first float switch **72** is turned on, the ignition switch **76** is turned on and the buzzer **78** does not ring before the engine starts, but the buzzer rings when the engine starts. On the other hand, in the case where the absence of the lubricating oil is detected and the second float switch **80** is turned on at the start of the engine, the buzzer **78** rings when the ignition switch **76** is merely turned on but before the engine starts.

In the case where the first float switch **72** detects the absence of the coolant and the engine is turned on in its ordinary running state, the buzzer **78** rings and simultaneously the engine may be operated at a low speed less than the second set rotating speed. When the second float switch **80** detects the absence of the lubricating oil and the engine is turned on, the buzzer **78** first rings and after an expiration of the predetermined time, the engine may be operated at a low speed less than the second set rotating speed.

Consequently, it is possible to easily discriminate which absence, coolant or lubricating oil, is detected.

As described above, according to the float switch of the invention, the float vertically swings with regard to the main body around one side thereof as a swinging central point. Due to the swing of this float, the fixed magnetic material is allowed to approach or be moved away from the contact, and the contact can be certainly closed or opened. Thus, there is no need to use a conventional long pipe member into which the float is vertically movably inserted, and the mechanism can be made small and of light weight. Also, the attaching position can be simply changed by merely shifting the main body to an arbitrary location.

In addition, according to the control apparatus of the internal combustion engine using the float switch of the invention, when the absence of the fluid is detected, the warning means and rotating speed control means are made operative in response to the absence signal, thereby informing the operator of the absence of the fluid by means of a warning and a reduction in rotating speed of the engine, so that the damage of the engine can be prevented.

Next, an embodiment of a warning apparatus for an outboard engine according to the present invention will be described hereinbelow with reference to FIGS. **10** to **13**.

FIG. **10** shows one embodiment of the warning apparatus according to the invention.

Constitution of the ignition apparatus

In FIG. **10**, a CDI (Capacitive Discharge Ignition) apparatus **100** is constituted in a similar manner as in a circuit which is generally known. One end of a capacitive charging coil **102** is connected to the ground and the other end is connected to the anode sides of diodes **104** and **106**, respectively. The cathode side of the diode **106** is connected to the ground through a stop switch **108**. On one hand, the cathode side of the diode **104** is connected to a capacitor **110** and an anode of a thyristor **112**, respectively. The capacitor **110** is connected to one end of the primary coil of an ignition coil **114**. The other end of this primary coil and the cathode side of the thyristor **112** are connected to the ground. A diode **116** is also connected in parallel to this primary coil. The secondary coil of the ignition coil **114** is connected to a spark plug **118**. A gate of the thyristor **112** is connected to the ground through a resistor **120** and is also connected to the cathode side of a diode **126** through a parallel circuit consisting of a capacitor **122** and a resistor **124**. Further, the anode side of the diode **126** is connected to the ground through a pulser coil **128**.

Operation of the ignition apparatus

The operation of the CDI apparatus **100** constituted as described above will now be described. When a flywheel is first rotated synchronously with a crankshaft (not shown), an electromotive force is generated in the capacitive charging coil **102**. Due to this electromotive force, a current flows through the closed circuit formed by the diode **104**, capacitor **110**, diode **116**, and ground, so that the capacitor **110** is charged.

Similarly, when the flywheel is rotated, an electromotive force is also generated in the pulser coil **128**. Due to this electromotive force, a current flows through a bias circuit consisting of the diode **126**, capacitor **122** and resistor **124** to the closed circuit formed by the resistor **120** and ground, so that a voltage is applied to the gate of the thyristor **112**. When the gate voltage of the thyristor **112** due to the resistor **120** reaches the trigger voltage of the thyristor **112**, the thyristor **112** is switched from the "OFF" state to the "ON" state.

Thus, the charges stored in the capacitor **110** are discharged by way of the circuit formed by the thyristor **112** and primary coil of the ignition coil **114**. Therefore, a current flows to the primary coil of the ignition coil **114** and further a high voltage is generated in the secondary side of the ignition coil **114**, and this high voltage is applied to the spark plug **118**, thereby causing the ignition. The foregoing operation is performed at every rotation of the flywheel and the engine is continuously operated. When the stop switch **108** is turned on, the charging coil **102** is short-circuited through the diode **106**, stop switch **108** and ground, so that the capacitor **110** is not charged. Therefore, the ignition of the spark plug **118** is not performed.

Constitution of the overspeed preventing apparatus

An overspeed preventing apparatus **200** will now be explained. The plus side of the foregoing capacitive charging coil **102** is connected to the anode side of a thyristor **202** serving as a suppression means. A rotating speed-detecting circuit **204**, serving as a rotating speed-detecting means and suppression means, is connected to the anode side and gate side of the thyristor **202**. On the other hand, the cathode side of the thyristor **202** is connected to the ground through a resistor **206** and is also connected to a spark extinction detecting circuit **208**. The detecting circuit **208** is further connected to a buzzer **402** through a resistor **210** and is also connected to a rotating speed switching circuit **214** serving as rotating speed setting means through a timer circuit **212**. The switching circuit **214** is connected through a resistor **216** to a collector of a transistor **326** in a coolant detecting apparatus **300** explained hereinafter. The cathode side of the thyristor **202** is connected to a light emitting diode **220** through a resistor **218**. The diode **220** is further connected to the ground. The resistor **218** and light emitting diode **220** are provided to inform the operator of the outboard engine that the engine is in the overspeed preventing state, namely, the spark extinction state, and they are connected as necessary.

Constitution of the coolant detecting apparatus

The coolant detecting apparatus **300** will now be explained. The plus side of the coil **102** is connected to one of AC side terminals of a rectifier **304** through a resistor **302**. Another AC side terminal of the rectifier **304** is connected to the ground. An output terminal on the plus side of the rectifier **304** is connected through a resistor **306** to the cathode side of a Zener diode **310**, one end of a resistor **312**, an emitter of a transistor **314**, and one end of a resistor **316**, respectively. In addition, a capacitor **308** is connected between the output terminals of the plus and minus sides of the rectifier **304**. The minus side output terminal is connected to the ground. Further, the anode side of the Zener diode **310** is also connected to the ground.

The other end of the resistor **312** is connected to a base of the transistor **314** and is also connected to a coolant sensor **318**. A collector of the transistor **314** is connected to a base of a transistor **322** through a resistor **320** and is further connected to the ground through a resistor **324**. An emitter of the transistor **322** is also connected to the ground. The other end of the resistor **316** is connected to a collector of the transistor **322** and a base of the transistor **326**, respectively. An emitter of the transistor **326** is connected to the ground.

In the foregoing circuit arrangement, the smoothing circuit to smooth an output waveform of the rectifier **304** is constituted by the resistor **306** and capacitor **308**. The Zener diode **310** serves to make the smoothed DC voltage constant. Further, the resistors **312**, **316**, **320**, **324** and transistors **314**, **322**, **326** constitute the amplifier to amplify an output of the coolant sensor **318**.

The collector of the transistor **326**, which serves as an output terminal of the foregoing amplifier, is connected to the cathode side of a diode **400**. The anode side of the diode **400** is connected to one end of the buzzer **402** and is also connected to one end of an oil level switch **404** having a oil level detecting function. The Other end of the Oil level switch **404** is connected to the ground. The other end of the buzzer **402** is connected to the plus side of a battery **408** through an ignition switch **406**. The minus side of the battery **408** is connected to the ground.

Constitution of the coolant sensor

The foregoing coolant sensor **318** will now be explained in detail with reference to FIGS. **11** to **13**. In these drawings, an outboard engine **500** has an upper casing **502** and a lower casing **504**. The upper casing **502** is attached to a transom of a ship (not shown) through a clamp bracket **506**. A propeller **508** is attached to the lower casing **504**.

The upper opening of the upper casing **502** is covered by an engine cowling **510** and an engine **512** is enclosed in this cowling. The coolant sensor **318** is attached to a cylinder head cover **514** of the engine **512**. As shown in FIG. **13**, the coolant sensor **318** has a structure such that an electrode **318B** made of aluminum or the like connected to a lead wire **318A** is arranged at the center. First, the electrode **318B** is enclosed in an electrode holder **318C** made of heat-resisting glass in such a manner that the front end portion is located inside of a water jacket **516** of the engine **512**. On one hand, the rear end portion of the electrode **318B** is exposed from the electrode holder **318C** and this exposed portion is connected to the lead wire **318A**. This connecting portion is fixed by means of a filler material **318D**. Further, the electrode holder **318C** is enclosed in a body **318E** consisting of an insulation material such as a resin or the like. The body **318E** is fixed to the uppermost portion or the portion near the top of the cylinder head cover **514** through a packing **318F** for increasing the sealing effect.

Overall operation of this embodiment

The overall operation of the foregoing embodiment will now be explained.

Overspeed preventing operation

The operation to prevent the overspeed of the engine **512** will first be explained. Generally, in the case where the propeller **508** is smaller than the specified size, then cavitation occurs during running, or when the ship to which this outboard engine is attached is of relatively light weight, a phenomenon is caused such that the rotating speed of the engine **512** abnormally increases. In this embodiment, if the rotating speed of the engine **512** is likely to exceed a predetermined speed, the rotation of the engine **512** is controlled by suppressing the ignition of the spark plug **118**, thereby preventing the overspeed of the engine **512**.

The rotating speed of the engine **512** is detected by the rotating speed detecting circuit **204**. Namely, the pulselike electromotive force is generated from the capacitive charging coil **102** and the period of this pulse is concerned with the rotating speed of the engine **512**. The electromotive force of the coil **102** is inputted to the detecting circuit **204** and the rotating speed is detected by way of this electromotive force.

When the rotating speed is below a set value, no signal is outputted from the detecting circuit **204** to the gate of the thyristor **202**. Therefore, the thyristor **202** is in the "OFF" state. Thus, the overspeed preventing apparatus **200** does not operate and the ignition apparatus **100** continues operation as mentioned above.

Next, when the rotating speed of the engine **512** increases and reaches the set value due to either of the above-mentioned reasons, a signal is outputted from the detecting circuit **204** to the gate of the thyristor **202**. Thus, the thyristor **202** is turned on and the plus side of the charging coil **102** is connected to the ground through the resistor **206**. Due to this, the capacitor **110** is not charged. Therefore, even if the thyristor **112** is turned on, no current flows through the primary coil of the ignition coil **114** and the ignition of the spark plug **118** is not performed. This results in reduction in rotational speed of the engine **512**.

However, when the rotating speed of the engine **512** decreases and falls below the set value, the gate signal output from the detecting circuit **204** is stopped, so that the capacitor **110** is again charged and the ignition of the spark plug **118** is performed.

Consequently, so far as the foregoing causes to increase the rotating speed of the engine **512** are not eliminated, the above-mentioned operation is repeated, causing a variation in speed of the engine near the set value as a center.

The vibration of the engine **512** increases more than the ordinary due to the foregoing reason, and the operator could have an unpleasant feeling. In such a situation, the operator generally intends to return a throttle valve (not shown) and thereby reducing the rotating speed to below the set value. However, in the case where there is hardly a difference in vibrational feeling between the oscillating state and the ordinary state of the engine, this oscillating state could be maintained. However, since the engine **512** is repeating the ignition and spark extinction states, there is a drawback such that the engine vibration frequently occurs and the service life of the engine is reduced. To prevent such a drawback, the spark extinction detecting circuit **208** is provided.

In more detail, when the rotating speed of the engine **512** increases and reaches the set value and the engine enters the spark extinction state, this state is detected by the detecting circuit **208**, so that the detecting circuit **208** is set into the "ON" state. This detection is made by checking the state of the cathode side of the thyristor **202**. Next, a signal indicative of the "ON" state is outputted from the detecting circuit **208** to the timer circuit **212**, so that the timer circuit **212** starts a predetermined time. After completion of the timing of the predetermined time, the rotating speed switching circuit **214** is made operative, so that the set value of the rotating speed which has been set in the detecting circuit **204** is switched from a first value to a second value. Namely, when the rotating speed first reaches the first value (for instance, 6000 rpm), the engine enters the spark extinction state, thereby allowing the rotating speed of the engine **512** to be restricted. When this state continues, the set value of the rotating speed is switched to the second value (e.g., 3000 rpm) after an expiration of a predetermined time (e.g., a few seconds). Thus, the rotating speed of the engine is reduced to the second value and the continuous operation at the first set value is prevented. When the operator returns the throttle valve and the rotating speed of the engine is reduced to below the second value, the operation of the engine at the second value is released, so that the ordinary operation can be executed.

In the foregoing operation, since the thyristor **202** is "ON" in the spark extinction state, a current flows through the resistor **218** to the light emitting diode **220**, so that the diode **220** emits the light. In other words, when the rotating speed of the engine **512** exceeds the set value, the light emitting diode **220** is lit so that the operator can easily know of the overspeed state.

Detecting operation of the coolant

Next, the detecting operation for the coolant of the engine **512** will be explained. First, when the ignition switch **406** is turned on to activate the engine **512**, the output of the charging coil **102** is rectified by the rectifier **304** and is converted to a DC output. Further, this output is smoothed by the smoothing circuit consisting of the capacitor **308** and resistor **306** and this output voltage is made constant by the Zener diode **310**.

On one hand, the coolant is pumped by a pump (not shown) due to the activation of the engine **512**; however, it takes a short time until the coolant reaches the upper portion of the water jacket **516**, namely, the position of the coolant sensor **318**. During this time, the resistance between the electrode **318B** of the coolant sensor **318** and the ground, i.e., the cylinder head cover **514**, is almost infinite. Therefore, the base current of the transistor **314** does not flow, so that the transistor **314** is turned off. The transistor **322** is also turned off since no base current flows.

However, since the transistor **326** is of the NPN type, the output voltage of the rectifier **304** is applied through the resistors **306** and **316**, so that the transistor **326** is turned on. The closed circuit is formed by the transistor **326**, diode **400**, buzzer **402**, ignition switch **406**, battery **408**, and ground, so that current flows through the buzzer **402** and this buzzer rings.

Further, when the transistor **326** is conductive, its collector is substantially at the earth potential and this potential is detected by the switching circuit **214** through the resistor **216**. The rotating speed of the engine **512** is set to the second value by the switching circuit **214**. Thus, the engine **512** is rotated at a speed below the second set value.

After a constant time, e.g., a few seconds has elapsed, the coolant rises into the upper portion of the water jacket **516** and soon reaches the position of the coolant sensor **318**. The resistance between the electrode **318**B of the sensor **318** and the cylinder head cover **514**, i.e., the ground, is reduced and becomes a value of, e.g., about hundreds of ohms. Thus, the base potential of the transistor **314** drops and this transistor is turned on. That is, a current flows through the emitter and base of the transistor **314** and coolant sensor **318**. The transistor **322** is also turned on and a current flows through the base and the collector becomes almost equal to the earth potential, thereby causing the transistor **326** to be turned off, so that the current supply to the buzzer **402** is stopped and the buzzer stops ringing.

At the same time, the increase in collector potential of the transistor **326** is detected by the switching circuit **214** and the set value in the detecting circuit **204** is switched from the second value to the first value, so that the ordinary engine operation can be performed.

That is, when the engine **512** is activated, the buzzer **402** rings and the rotating speed of the engine is suppressed to the second value. This operational state continues until the level of the coolant in the water jacket **516** reaches the sensor **318** When the coolant reaches the sensor **318**, the buzzer **402** stops ringing and the rotating speed of the engine **512** is set to the first value.

Consequently, the operator can audibly check whether or not the coolant is supplied to the cylinder of the engine **512** by the ringing of the buzzer **402**. In addition, since the rotating speed of the engine **512** is suppressed until the coolant is sufficiently supplied into the water jacket **516**, the engine **512** can be protected.

Subsequently, if the coolant is not supplied to the cylinder during the running of the engine due to some reason, the level of the coolant in the water jacket **516** drops and the resistance value between the sensor **318** and the ground increases and the buzzer **402** rings due to the foregoing operation, and at the same time the rotating speed of the engine **512** is suppressed to the second value and the spark plug **118** is placed in the spark extinction state. Thus, the abnormal state of the coolant is informed to the operator and the engine **512** is protected. In this case, the light emitting diode **220** is also lit, thereby enabling the ôperator to visually know the abnormal state.

Further, when such a cause of the abnormal state of the coolant is solved, the level of the coolant again rises to the position of the coolant sensor **318** and the buzzer **402** stops ringing due to the foregoing operation and the engine **512** returns to its normal operating state. Since each electric power consumption of the overspeed preventing apparatus **200** and coolant detecting apparatus **300** is very small, the operation of the CDI apparatus **100** is not influenced by the above-mentioned operation.

Operation in the oil warning

The operation in the oil warning system will now be described. The oil level switch **404** is attached in the oil tank of the engine **512** and is turned off when the amount of the oil is over a specified value, while it is turned on when the oil amount is below the specified value.

Now, assuming that the oil amount becomes below the specified value during engine running and the oil level switch **404** is turned on, a current is supplied from the power source **408** to the buzzer **402** and the buzzer **402** rings. On the other hand, the ON-operation of the switch **404** is detected by the timer circuit **212** as a change in potential at a node P, so that the timer circuit **212** starts the foregoing predetermined timing. After completion of this timing operation, the set value in the rotating speed detecting circuit **204** is switched from the first value to the second value by the switching circuit **214** as mentioned above, so that the rotating speed of the engine **512** is suppressed. As the result of these operations, the operator is warned as to the lack of the proper oil level, and the engine **512** is protected.

The operation upon a low oil level warning and the operation when the coolant is abnormal are similar with regard to the points that the buzzer **402** rings and the rotating speed of the engine **512** is suppressed. However, the buzzer ringing and speed suppressing operations are almost simultaneously executed when the coolant is abnormal. On the other hand, at the time of a low oil level warning, the rotating speed of the engine **512** is suppressed after expiration of a predetermined time, e.g., a few seconds after the buzzer **402** rings. Therefore, the operator can discriminate from such difference which abnormal state, i.e., coolant or lubricating oil, occurs.

As described above, according to this embodiment, since the power source of the coolant detecting apparatus **300** is derived from the electromotive force of the capacitive charging coil **102**, the invention can be applied as well to an engine using no battery. In addition, since the buzzer **402** rings continuously until the coolant is sufficiently supplied after the activation of the engine, the cooling function can be checked beforehand. Also, since the timer circuit for prevention of overspeed and the timer circuit to control the rotating speed for the oil warning are commonly used, the circuit arrangement is simple. Further, there are effects such that it is possible to distinguish between the abnormal state of the coolant and the oil warning from the difference between the operation times of the buzzer ringing and of the speed control, and thus the reduction in the service life of the engine can be prevented.

Although the denominations of "plus side" and "minus side" were used for the coils **102** and **128** in the description of the above embodiment, these words are used for easy understanding and do not denote that the electromotive forces of the coils **102** and **128** are DC powers.

As explained above, according to this embodiment, the warning apparatus of an outboard engine which controls the operation of the engine when an abnormality occurs comprises: rotating speed detecting means for detecting a rotating speed of the engine; rotating speed setting means for setting the rotating speed of the engine in corresponding to an abnormality; and suppressing means for suppressing the rotating speed of the engine when the detected rotating speed of the engine exceeds a preset value. Therefore, there are effects such that the overheating of the engine can preferably be prevented with regard to various kinds of abnormal conditions, and that the reduction of the service life of the engine can be prevented.

Although the present invention has been shown and described with respect to preferred embodiments, various changes and modifications which are obvious to a person skilled in the art to which the invention pertains are deemed to lie within the spirit and scope of the invention.

What is claimed is:

1. A switch for sensing fluid flow therepast in a first direction, comprising: a main body having thereon an outward projection which extends generally transverse to said first direction; a reed switch provided on said projection; and a member having a magnet thereon and supported on said main body for movement between first and second positions in which said magnet is respectively adjacent and spaced from said reed switch, said reed switch being actuated by the magnetic field of said magnet when said magnet is in said position adjacent said reed switch, said member including a portion having thereon a substantially flat surface which faces in a second direction substantially opposite said first direction, said portion moving approximately in said first direction as said member moves away from said first position thereof; wherein said member is supported at one end on said main body for pivotal movement about a pivot axis which extends in a direction transverse to the direction in which said projection projects outwardly from said main body and transverse to said first direction; wherein said portion of said member is an enlarged end portion at an end thereof remote from said pivot axis; wherein said projection has a convex surface thereon which faces said member and said member has in said substantially flat surface a groove containing a concave surface which faces said projection; wherein in said first and second positions said concave and convex surfaces are respectively adjacent and spaced from each other; wherein in said adjacent position of said convex and concave surfaces said magnet and said reed switch are in said adjacent position and said enlarged end portion of said member projects outwardly past an outer end of said outward projection; and wherein said magnet is partially embedded in said member but has a portion which projects outwardly from said concave surface into said groove.

2. The switch according to claim **1**, wherein said main body includes an attaching portion having thereon a cylindrical and radially outwardly facing surface, said cylindrical surface having therein an annular groove, and including an O-ring disposed in said annular groove.

3. The switch according to claim **1**, wherein said main body and said projection thereon are integral portions of a single structural element made of a nonmagnetic material.

4. The switch according to claim **1**, wherein said pivot axis extends substantially parallel to said substantially flat surface, and wherein said substantially flat surface extends the full width of said portion of said member in a direction parallel to said axis.

5. The switch according to claim **1**, wherein said substantially flat surface and said groove therein each extend to an end of said member remote from said axis.

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